

# FMCS 1-Maths 06/07: Assignment 2

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## Rectangular filter

Given a filter kernel  $K$  with  $K(t) = \frac{1}{T}$  if  $0 < t < T$ , and  $K(t) = 0$  otherwise.  $T$  is a fixed parameter of the kernel. Convolution with this kernel acts as taking a running average. We research the convolution of periodic functions.

- a) Convolve the kernel with the periodic signal  $g(t) = \sin(2\pi ft)$ . Call the result  $g^*(t)$ .
- b) Do a first order Taylor expansion of  $g^*(t)$  w.r.t.  $T$  around  $T = 0$ , i.e. this would a good approximation for  $g^*(t)$  when  $2\pi fT \ll 1$ . Explain the result.
- c) For which values of  $T$  is  $g^*(t) = 0$  for all  $t$ ?
- d) For a given  $f$  and  $T$ ,  $g^*$  will have a maximum for  $t = 0$ . Sketch the value of the maximum as a function of  $T$  for the case that  $f = 1$ . Interpret your result.